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ScienceDirect

Procedia Engineering 180 (2017) 822 – 831

Procedia Engineering

www.elsevier.com/locate/procedia

International High- Performance Built Environment Conference – A Sustainable Built Environment Conference 2016 Series (SBE16), iHBE 2016

Proposal for an open data model schema for precinct-scale information management

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Abstract

This paper reports on a project currently underway to investigate how an open exchange standard for modelling information at the scale of an urban precinct can be used to support integrated solutions to achieve low carbon targets in the built environment. The project is part of a major research initiative to deliver on low carbon targets in Australia. The project builds on the concept of BIM to develop an object-oriented approach to modelling the built environment at a broader urban scale, focusing in the first instance on a precinct, being any region within an urban context that can be regarded as an integrated whole for the purposes of planning, design or management. This approach is referred to as precinct information modelling (PIM) and provides a key mechanism to bridge the information modelling gap between building scale (BIM) and the spatial scale. The paper argues the case for such an approach, proposing that the current IFC data model, and recent work that is investigating how that data model can be extended to handle transport infrastructure elements such as roads and bridges, can be adapted with modest extensions to serve this purpose. The paper describes this approach, proposing an initial data model and addressing several key strategies and principles that influence the work (e.g. commonality of concepts to maintain semantic integrity and the use of data dictionaries to define concept hierarchies). The paper offers a review of current approaches, reflects on a couple of trial implementations and provides a discussion of how this work can be carried forward.

Peer-review under responsibility of the organizing committee iHBE 2016

Keywords: Precinct information modelling; spatial modelling; open data; digital built environment; data exchange standards

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Peer-review under responsibility of the organizing committee iHBE 2016
doi:10.1016/j.proeng.2017.04.243

1. Introduction

There has been growing interest over the past 5-10 years in the development of digital representations of the built environment at a broad scale. 3D City models are now used routinely for urban planning and scenario analysis, generally used for visualization, over-shadowing and determination of sight lines. Emerging trends in the development of smart cities rely on ubiquitous access to digital data through the use of sensors, smart meters and location-based mobile apps linked to real-time data and spatial models of the built environment. The Internet of Things, facilitated by embedded RFID tags, adds a further dimension to create visions of a virtual digital built environment that mirrors and connects to the physical world and, in doing so, facilitates and enhances the way people use and enjoy built space.

The work reported here focusses on a specific aspect of that larger picture, taking as the starting point a "digestible" part of the built environment referred to as a precinct, being any region within an urban context that can be regarded as an integrated whole for the purposes of planning, design or management. A precinct might be the subject of an urban renewal project, or it may be a new (or existing) housing estate, a neighbourhood linked to a transport node, or even a rural area in need of agricultural management.

This leads to the definition of a precinct information model (PIM) as a comprehensive 3D digital database representation that contains all the information needed to support planning, design, development, construction, management, operation, use and retro-fitting of urban precincts. It is a concept that very clearly derives from the concept of building information modelling (BIM), a technology (or more precisely, a process enabled by a technology) that is gaining wide acceptance across the construction sector to achieve better design outcomes at lower cost across the entire supply chain. Significantly, BIM is now becoming a misnomer as the same technology and approach is being adopted in the delivery of large infrastructure projects such as roads, bridges, railways and tunnels. Importantly, the focus of much of this innovation is on life cycle modelling, and particularly, the development of new asset management strategies.

From a technical perspective, PIM is really an extension of BIM, but its significance goes far beyond that simple characterization. A PIM allows the placement of a BIM within its geospatial context, both in terms of the immediate neighbourhood as well as the wider socio-economic or geographic context. It moves the focus away from the design or management of a single built facility (and the risk of ignoring its interactions) to a view of the built environment as a complex, but integrated, whole. This is crucially important from the perspective of this particular research project where the focus is directed towards the minimisation of carbon emissions throughout the entire life cycle of a precinct: carbon can minimised in the all-of-life management of individual buildings, infrastructure, urban space and service utilities, but the impact is multiplied if these entities are managed in a cooperative fashion, especially where end user engagement is leveraged through better access to information. This reflects the view expressed of Osman and El-Diraby [1] who argue that the interoperation of domain information in land use, infrastructure and public utilities in the management of utility inventories has positive flow-on effects for capital budget allocation; the routing of new infrastructure in high density urban corridors; and the appreciation of the surrounding land use.

Since the physical world is made up of constructed elements or managed natural features, generally planned or designed for human convenience, it is natural to construct a PIM as a collection of objects (building, bridge, road, park, etc.) and then associate property/performance data or information with those objects. Importantly, that data may be drawn from all kinds of existing sources through live database links: usage data, planning data, utility data, social data, product performance data, etc. The result is a rich information repository, linked to spatial data and processes for analysis, at a scale that supports the development of integrated solutions to address the complex issue of carbon management in the built environment.

A key aspect of this work is a focus on open information exchange standards, based on the premise that integrated solutions rely on interoperability of information across diverse software applications and throughout all stages in the life of a precinct. To create those standards, data schemas are developed that define how to describe the entities that constitute a precinct in a comprehensive and accurate manner, while linking those concepts to associated object libraries that hold property data for commonly-used entities. This is illustrated in Fig. 4 (near the end of the paper), and hinges on the provision of a single point of truth (though not necessarily held in a single database) that can receive or deliver information sets (or sub-models) that satisfy the needs of a specific process, activity or analysis. To that end, this work aims to contribute to the development of an open standard (an extension